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Miura et al.

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(54) **ELEMENT SUBSTRATE AND PRINT HEAD**

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B41J 2/14 (2006.01)

(52) **U.S. Cl.**
CPC ***B41J 2/14072*** (2013.01)

(58) **Field of Classification Search**
CPC B41J 2/14072
See application file for complete search history.

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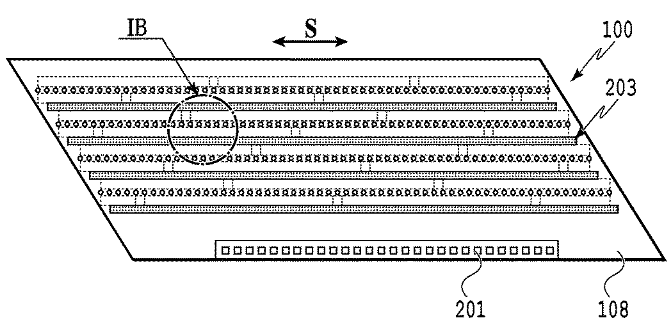
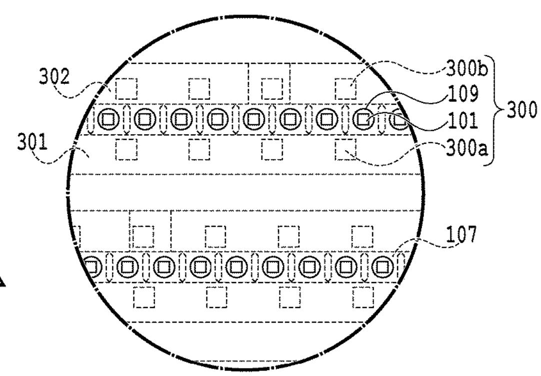
(57) **ABSTRACT**

According to the present invention, it is possible to provide an element substrate and a print head with which a decrease in yield and an increase in cost in a manufacturing process can be suppressed. For that purpose, a VH wiring line and a GNDH wiring line are provided in parallel in the same layer.

11 Claims, 9 Drawing Sheets





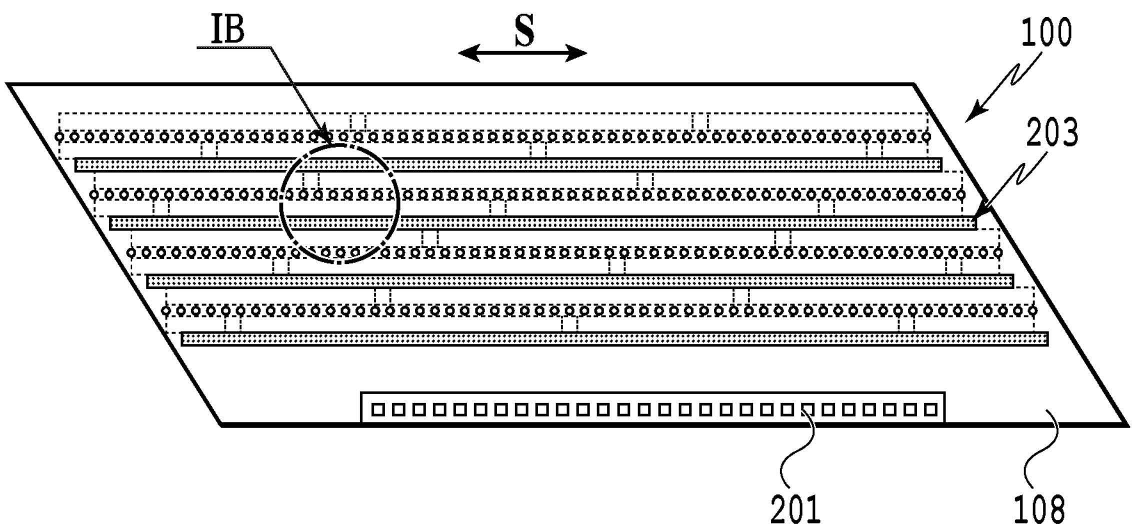


FIG.1A

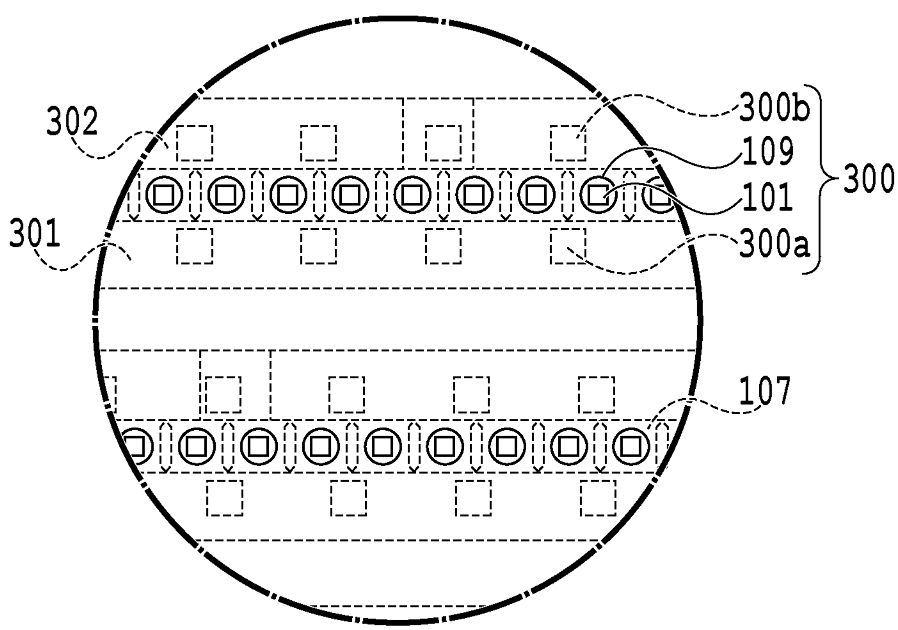


FIG.1B

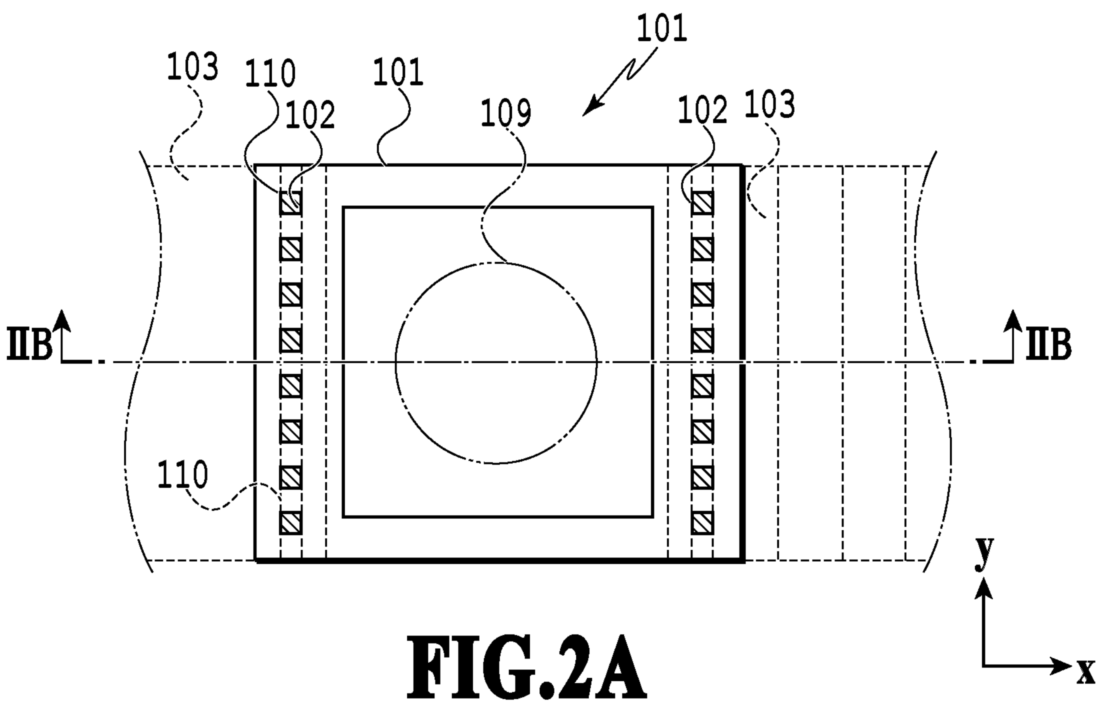

101
103
110
102
101
109
102
103
IIB
IIB
110
y
x

FIG.2A

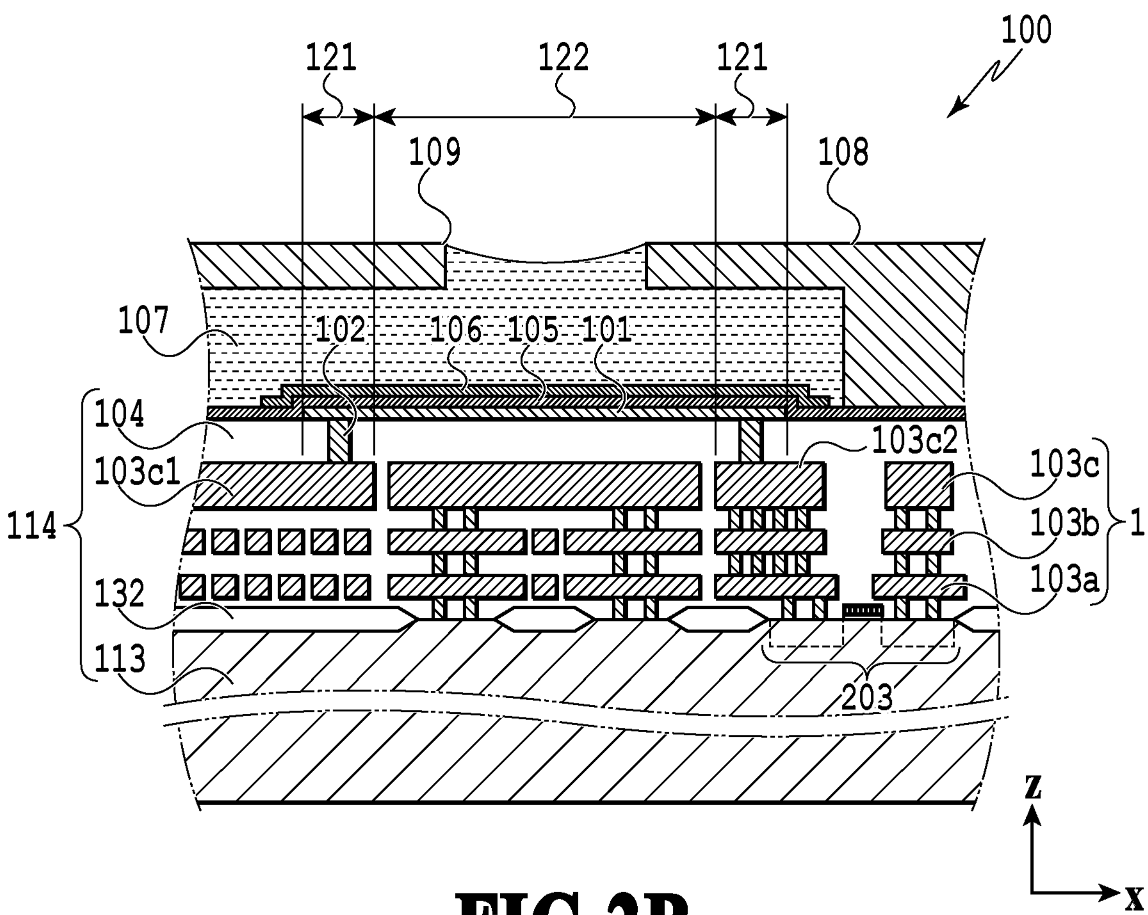

100
121
122
121
109
108
107
102
106
105
101
104
103c2
103c1
103c
103b
103
114
132
103a
113
203
z
x

FIG.2B

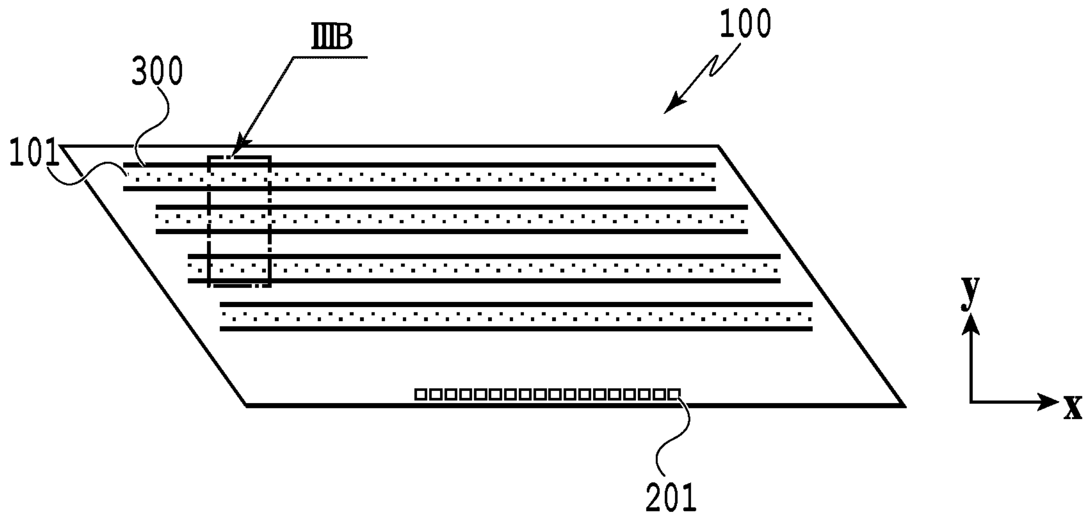


FIG.3A

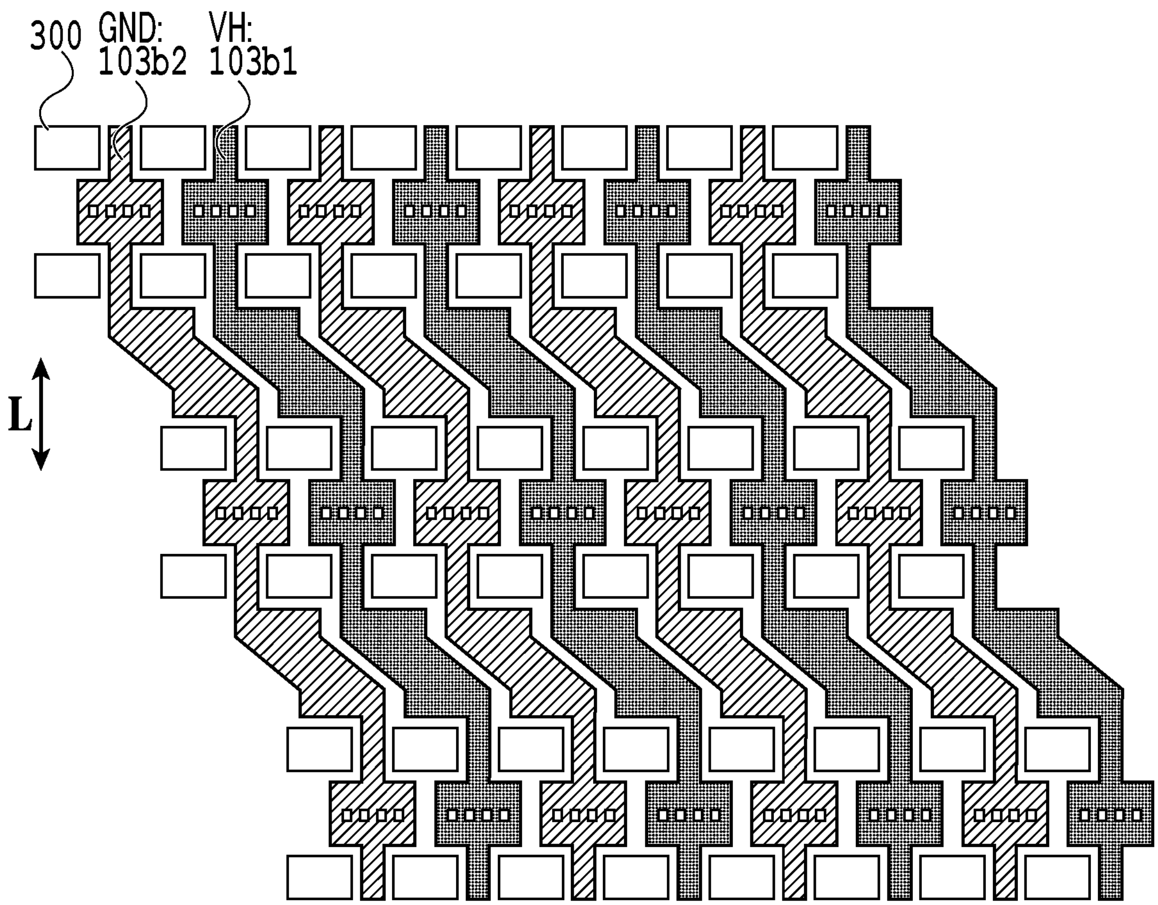


FIG.3B

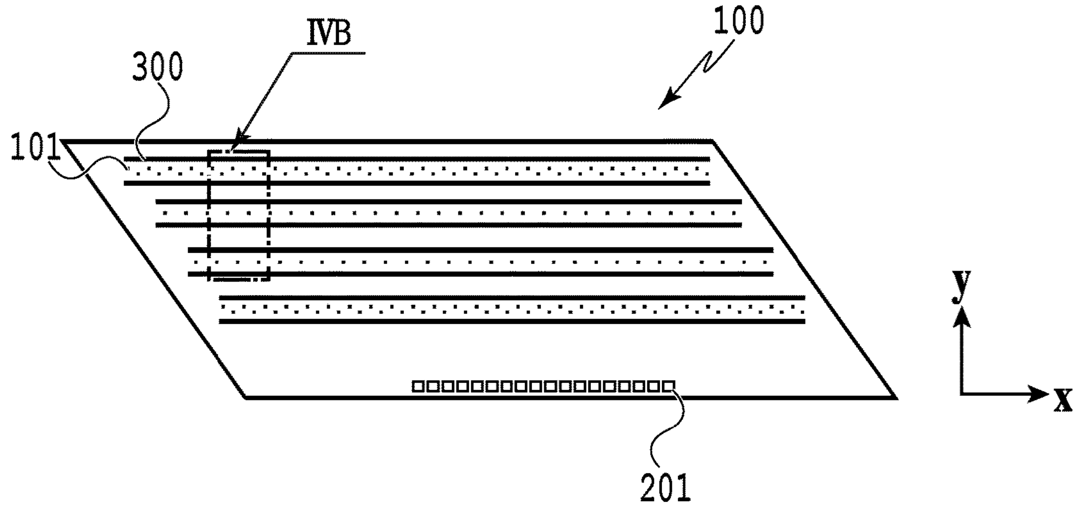


FIG.4A

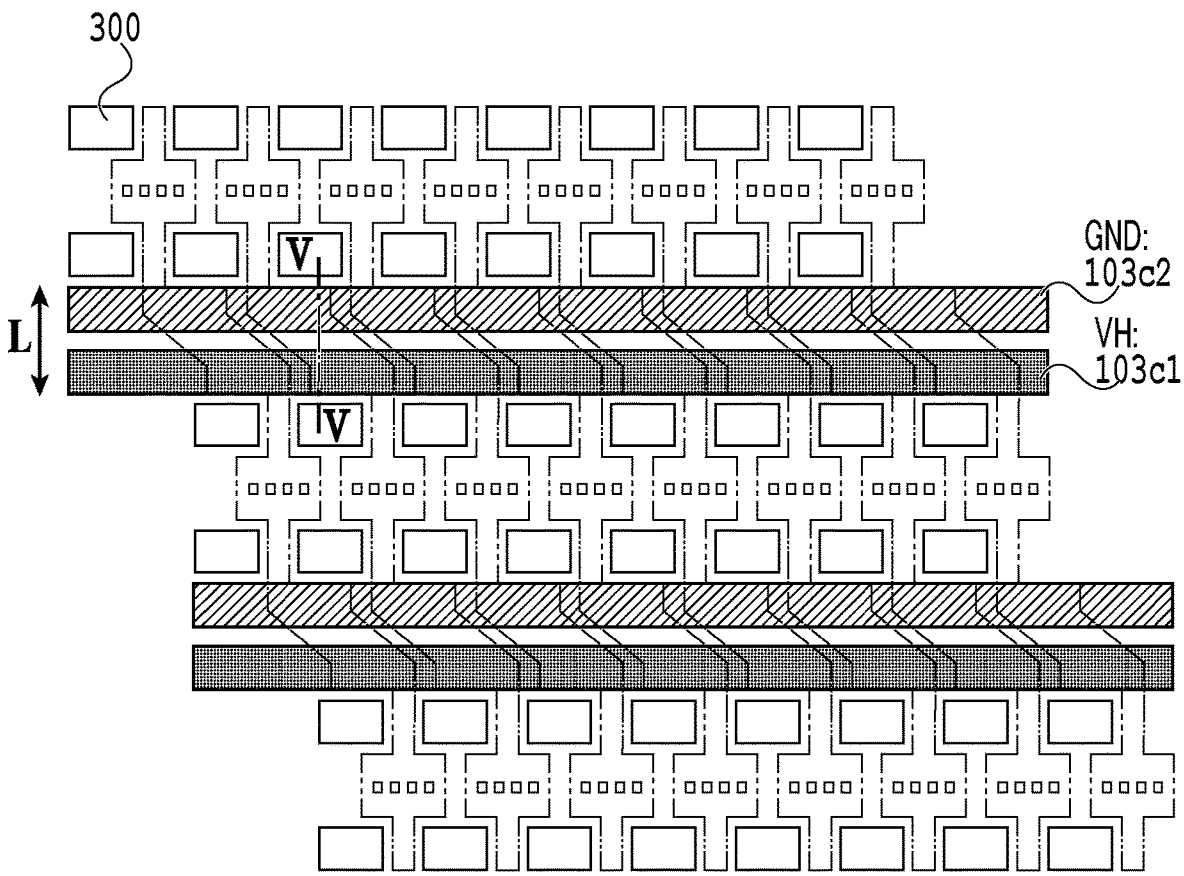


FIG.4B

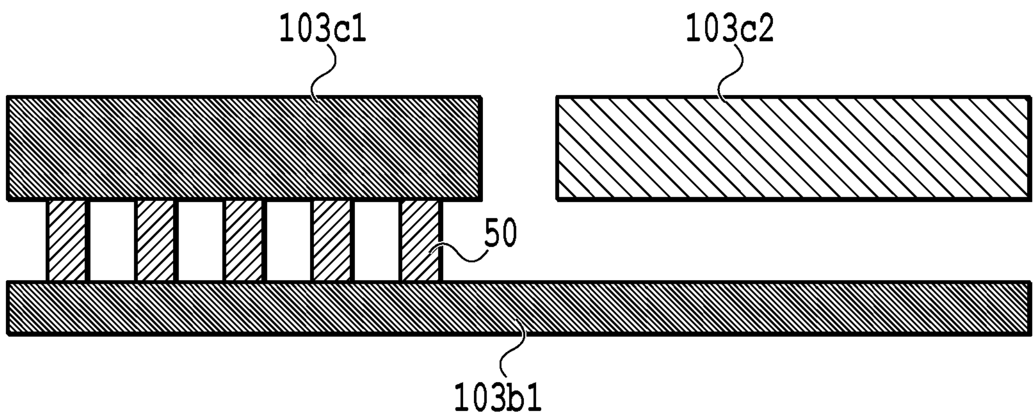


FIG.5

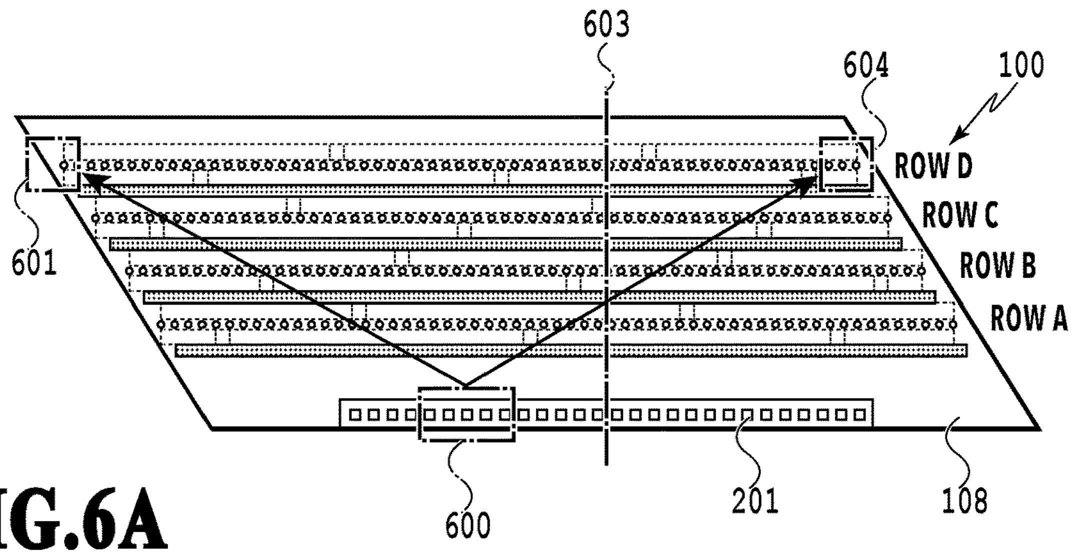


FIG.6A

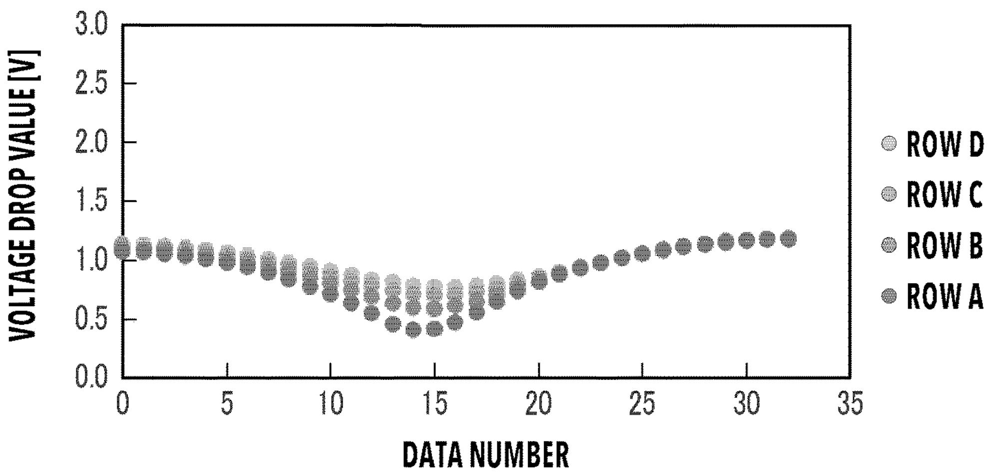


FIG.6B

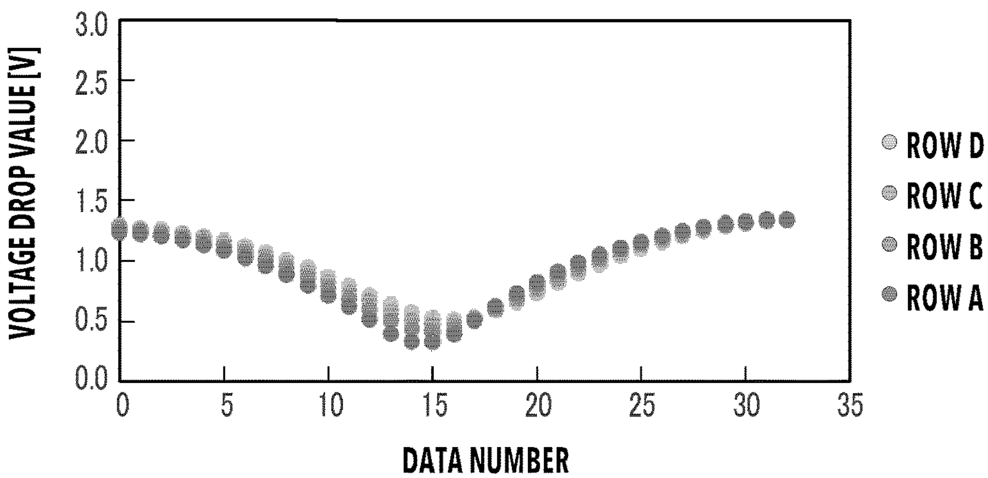


FIG.6C

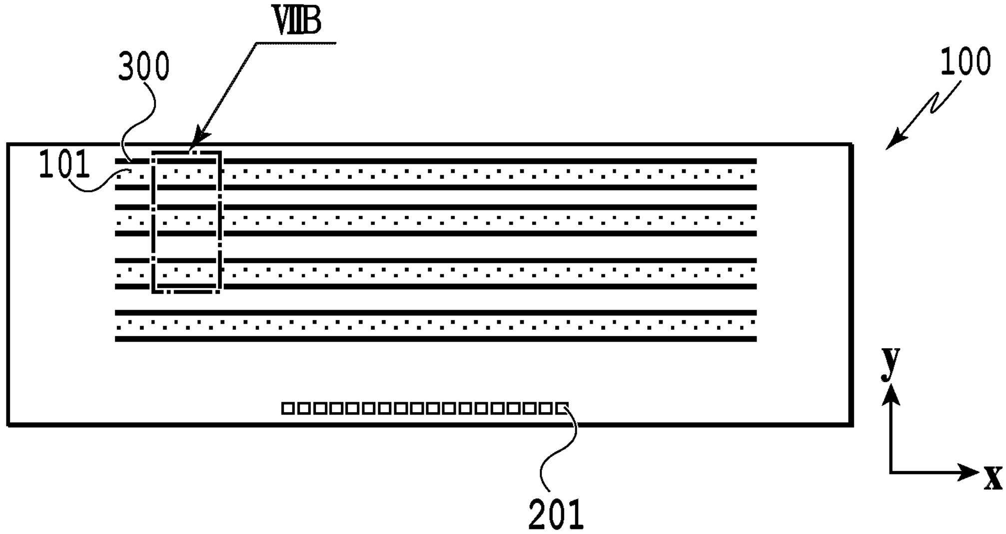


FIG.7A

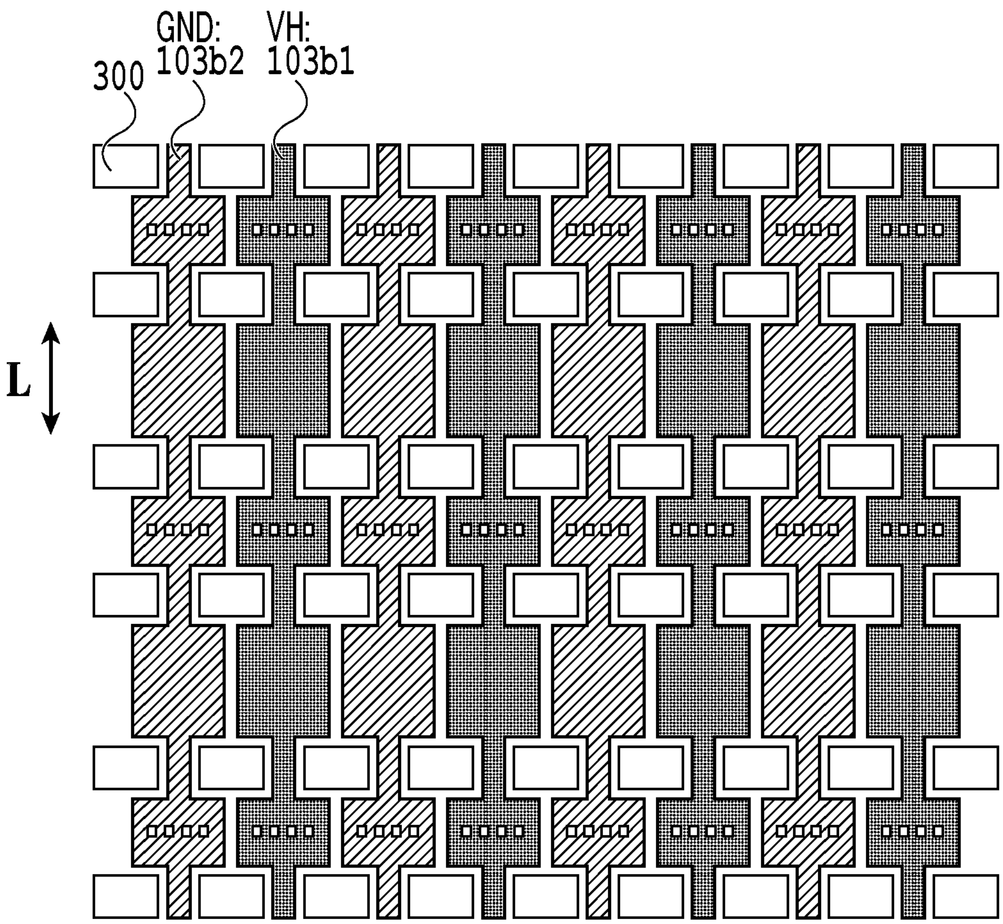


FIG.7B

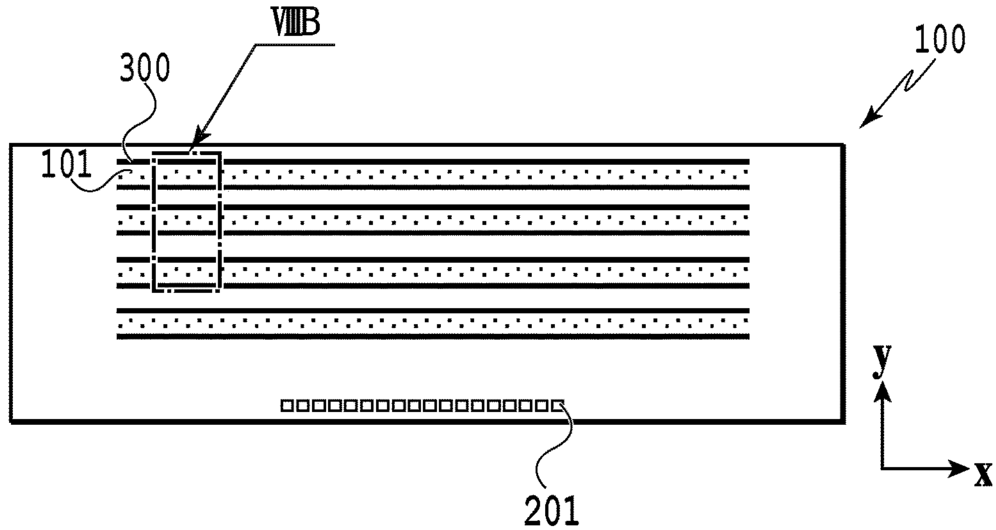


FIG.8A

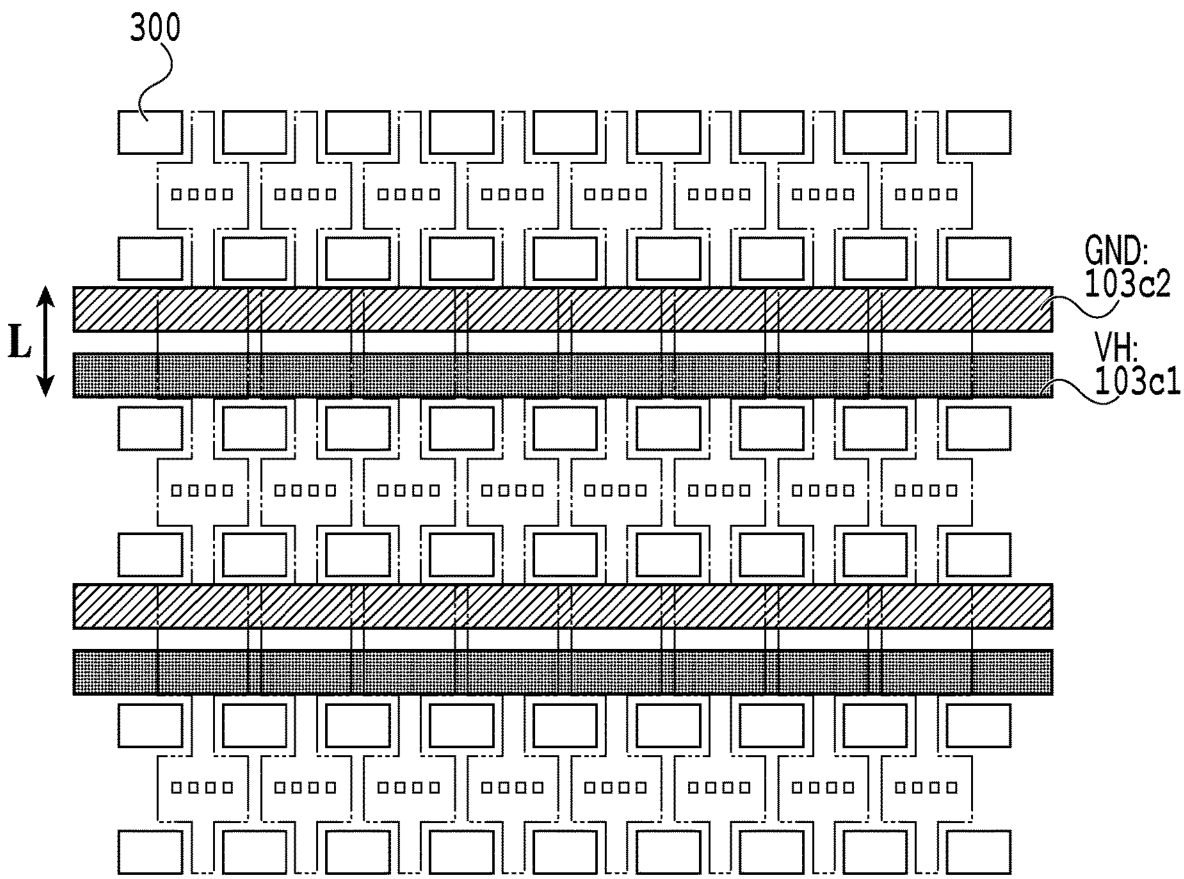


FIG.8B

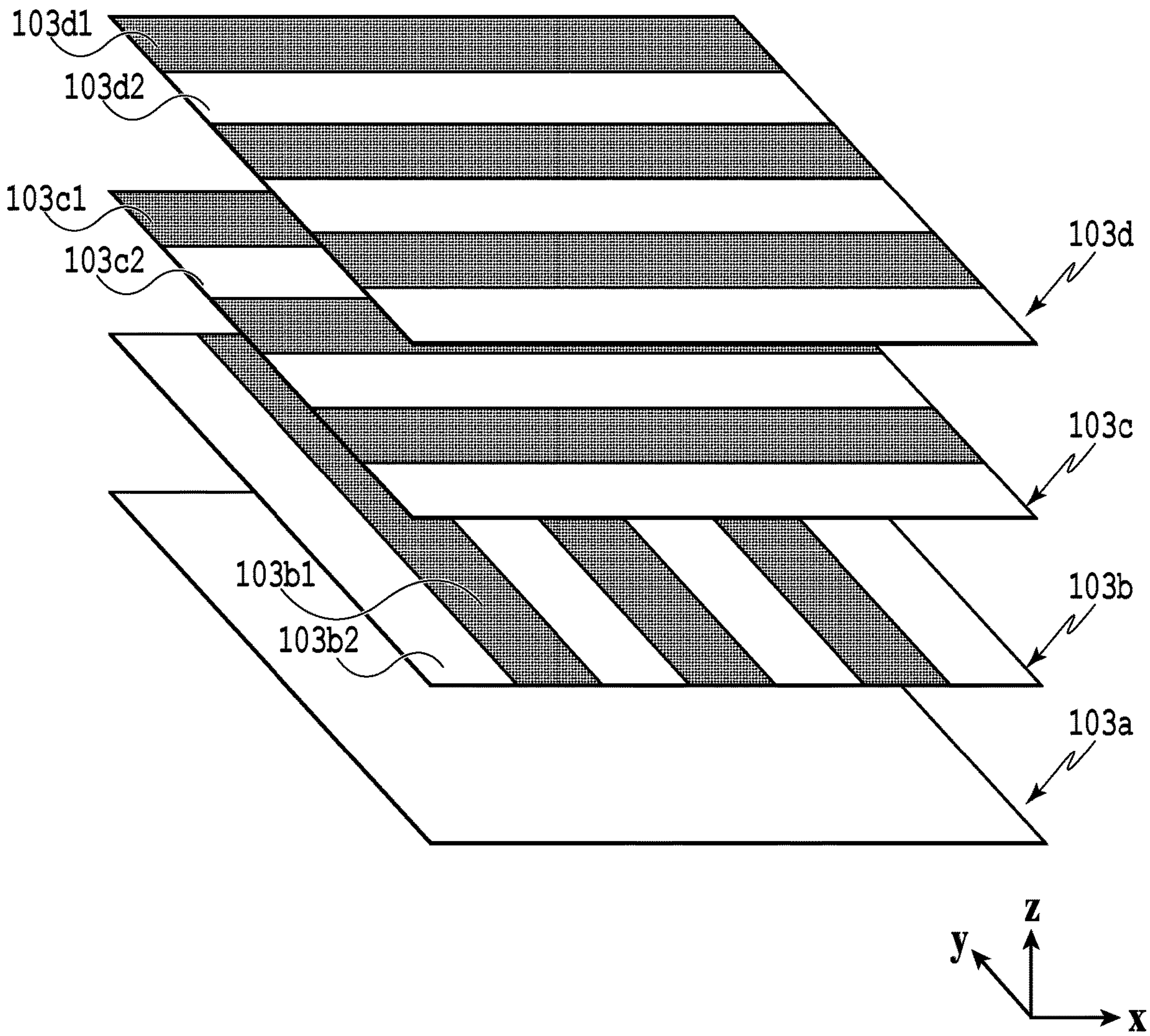


FIG.9

ELEMENT SUBSTRATE AND PRINT HEAD

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to an element substrate for a print head ejecting a liquid to perform printing and a print head.

Description of the Related Art

As a print speed and image quality increase in recent years, the number of heating elements mounted on a print head tends to increase. Thus, as the area of an element substrate on which a circuit for driving those heating elements is mounted increases, it has become important to optimize an arrangement of the heating elements or a wiring layout in a case where the shape of the element substrate is a parallelogram, a trapezoid, or the like in order to mount a plurality of element substrates on the print head.

Japanese Patent Laid-Open No. 2016-137705 discloses a liquid ejection head using an element substrate in which a positive side wiring (VH wiring) layer for passing a current through a heating element and a negative side wiring (GNDH wiring) layer are provided, the VH wiring layer and the GNDH wiring layer facing each other.

However, in the configuration of Japanese Patent Laid-Open No. 2016-137705, since different power supply wiring lines (a VH wiring line and a GNDH wiring line) face each other in a large area, there is a possibility that the frequency of interlayer short circuits caused by foreign matter increases at the time of generating a wiring line and there is concern that yield decreases. Further, there is also concern that each of the VH wiring line and the GNDH wiring line uses one layer, which costs.

SUMMARY OF THE INVENTION

Thus, the present invention provides an element substrate and a print head with which a decrease in yield and an increase in cost in a manufacturing process can be reduced.

Accordingly, the element substrate of the present invention includes a plurality of arranged heating elements and an electrical wiring line configured to supply the heating elements with power, the electrical wiring line being provided in a first electrical wiring layer and a second electrical wiring layer overlapping the first electrical wiring layer, wherein the first electrical wiring layer includes a first wiring line connected to one connecting unit of the heating elements and a second wiring line connected to the other connecting unit of the heating elements, wherein the second electrical wiring layer includes a third wiring line connected to the first wiring line and a fourth wiring line connected to the second wiring line, the first electrical wiring layer including a first wiring group in which at least one pair of the first wiring line and the second wiring line are provided in parallel, the second electrical wiring layer including a second wiring group in which at least one pair of the third wiring line and the fourth wiring line are provided in parallel, wherein a wiring line of the first wiring group and a wiring line of the second wiring group intersect when viewed from a viewpoint of a line orthogonal to the first electrical wiring layer, and wherein the first wiring group and the second wiring group are different in wiring thickness.

According to the present invention, it is possible to provide an element substrate and a print head with which a decrease in yield and an increase in cost in a manufacturing process can be suppressed.

Further features of the present invention will become apparent from the following description of exemplary embodiments with reference to the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1**A is a plan view showing an element substrate;

FIG. **1**B is an enlarged view showing a portion IB in FIG. **1**A;

FIG. **2**A is a plan view of a heating element;

FIG. **2**B is a cross-sectional view taken along a line IIB-IIB in FIG. **2**A;

FIG. **3**A is a plan view of the element substrate;

FIG. **3**B is an enlarged view of an electrical wiring layer;

FIG. **4**A is a plan view of the element substrate;

FIG. **4**B is an enlarged view of the electrical wiring layer;

FIG. **5** is a diagram showing through holes between electrical wiring layers;

FIG. **6**A is a diagram illustrating wiring resistance;

FIG. **6**B is a diagram showing a simulation result of a voltage drop;

FIG. **6**C is a diagram showing a simulation result of a voltage drop;

FIG. **7**A is a plan view of the element substrate;

FIG. **7**B is an enlarged view of the electrical wiring layer;

FIG. **8**A is a plan view of the element substrate;

FIG. **8**B is an enlarged view of the electrical wiring layer; and

FIG. **9** is a diagram showing a power supply wiring layer.

DESCRIPTION OF THE EMBODIMENTS

First Embodiment

A description will be given below of a first embodiment to which the present invention can be applied with reference to the drawings. A subject below is an inkjet print head causing ejection of ink for printing, but the present embodiment can be applied to a print head that ejects any liquid.

FIG. **1**A is a plan view showing an element substrate **100** in the present embodiment and FIG. **1**B is an enlarged view showing a portion IB in FIG. **1**A. The element substrate **100** has a plane shape of a parallelogram and includes a plurality of heating elements **101** in a plurality of rows, a drive circuit **203** configured to drive each of the heating elements **101**, and an electrode pad **201** configured to transfer a driving current to the heating element **101**. Further, the element substrate **100** includes an ejection port forming member **108** formed by aligning a plurality of ejection ports **109** provided in correspondence with the heating elements **101** in rows along an arrow S direction. In the print head, a plurality of the element substrates **100** are arranged in the arrow S direction. The drive circuit **203** is connected to an electrode pad **201** and generates a driving current for the heating element **101** according to a print signal supplied from the outside of the print head via the electrode pad **201**.

In the element substrate **100**, a liquid supply path **301** and a liquid collection path **302** extend in the arrow S direction and the liquid supply path **301** and the liquid collection path **302** is provided with a plurality of openings **300** (a supply port **300***a*, a collection port **300***b*), respectively. The liquid supply path **301** is provided with a plurality of the supply ports **300***a* capable of supplying the heating elements **101** with a liquid, and the liquid collection path **302** is provided with a plurality of the collection ports **300***b* capable of collecting the liquid from the heating elements **101**. The liquid supplied to a pressure chamber **107** from the supply port **300***a* of the liquid supply path **301** is heated by the heating element **101** and foamed, so that the liquid is ejected from each of the ejection ports **109**. The liquid supplied from the supply port **300***a* and not ejected is collected at the collection port **300***b* in the liquid collection path **302**. The ink collected at the collection port **300***b* is supplied to the liquid ejection head again via a tank unit (not shown) or the like provided in a printing apparatus. In this way, the liquid circulates in the printing apparatus. The supply port **300***a* and the collection port **300***b* are through holes that penetrate a substrate **114** in the element substrate **100** (see FIG. **2**B to be described later). As described above, by sandwiching the heating element **101** between the supply port **300***a* and the collection port **300***b*, refilling after ejection can be performed at a relatively high speed.

FIG. **2**A is an enlarged plan view of a peripheral area of one heating element **101** in the element substrate of the print head of the present embodiment and FIG. **2**B is a cross-sectional view taken along a line IIB-IIB in FIG. **2**A. The heating element **101** is provided so as to face the ejection port **109** and is provided with a plurality of connecting members **102** connecting an electrical wiring line **103** and the heating element **101**.

Hereinafter, the direction of a current flowing through the heating element **101** is defined as an X direction and a direction orthogonal to the X direction is defined as a Y direction. Additionally, a direction orthogonal to the X direction and the Y direction is defined as a Z direction. The Y direction is a direction in which the heating elements **101** or the ejection ports **109** are arranged. The Z direction is a direction orthogonal to a surface on which the ejection port is formed and is a direction in which the liquid is ejected.

The element substrate **100** includes the substrate **114** and the ejection port forming member **108**. The substrate **114** includes a base material **113** formed of Si and an insulating film **104** formed on the base material **113**. On the substrate **114**, the heating element **101** that generates heat energy for ejecting a liquid, a protective film **105**, and a cavitation resistant film **106** are provided. The heating element **101** is formed of a Ta compound such as TaSiN. The insulating film **104** is formed of an insulator such as SiO. The ejection port forming member **108** is provided on the surface of the substrate **114** on which the heating element **101** is formed. The ejection port forming member **108** includes the ejection ports **109** corresponding to respective heating elements **101** and forms the pressure chamber **107** for each ejection port **109** together with the substrate **114**.

In the insulating film **104** provided on the substrate **114**, the electrical wiring line **103** for supplying the heating element **101** with a current is provided so as to be embedded in the insulating film **104**. The electrical wiring line **103** electrically connects the drive circuit **203** and the heating element **101** via each of the connecting members **102**. The electrical wiring line **103** is made of aluminum and has a film thickness (a dimension in the Z direction) of about 0.4 to 1.2 μm. The heating element **101** generates heat due to the supplied current, and the heating element **101** having a high temperature heats the liquid in the pressure chamber **107** to generate bubbles. The bubbles cause the liquid in the vicinity of the ejection port **109** to be ejected from the ejection port **109** and printing is performed. The heating element **101** is covered with the protective film **105** made of SiN. The protective film **105** may be formed of SiO or SiC. The protective film **105** is covered with the cavitation resistant film **106**. The cavitation resistant film **106** is made of Ta or Ir. The electrical wiring line **103** is a metal and may be any one of Al, Cu, Ag, Au, Pt, W, Ni, and Co or an alloy including any one of Al, Cu, Ag, Au, Pt, W, Ni, and Co.

The connecting members **102** are positioned at intervals along the Y direction. Each of the connecting members **102** is covered with the heating element **101** when viewed from a direction orthogonal to the surface on which the heating element **101** is provided. The connecting member **102** connects the electrical wiring line **103** and the heating element **101** in the vicinity of both end portions in the X direction of the heating element **101**. Accordingly, the current flows in the X direction in the heating element **101**. The heating element **101** includes, at one end side and the other end side, connection areas **110** to which a plurality of connecting members **102** are connected. The connecting member **102** is a plug extending in the Z direction from the vicinity of an end portion of the electrical wiring line **103**. The connecting member **102** has a substantially square cross section in the present embodiment, but corners may be rounded, and the shape of the cross section is not limited to a square but may be another shape such as a rectangle, a circle, or an ellipse.

The connecting member **102** is made of tungsten but can be formed of any one of titanium, platinum, cobalt, nickel, molybdenum, tantalum, and silicon, or a compound thereof. The connecting member **102** may be integrally formed with the electrical wiring line **103**. That is, the connection member **102** integrated with the electrical wiring line **103** may be formed by cutting out a portion of the electrical wiring line **103** in a thickness direction.

The electrical wiring line **103** is provided in the insulating film **104** and is connected to the heating element **101** via the connecting member **102**. Since electrical connection is made to the heating element **101** from a back surface side in this way, there is no need for an electrical wiring line covering the front surface side of the heating element **101**. In a configuration in which the electrical wiring line **103** is connected to the front surface side of the heating element **101**, an electrical wiring line having a film thickness of about 0.6 to 1.2 μm is laminated on the heating element **101**. Thus, there is a need to provide a protective film having a relatively large film thickness in order to secure a coverage property for a step height of about 0.6 to 1.2 μm.

In contrast, in the present embodiment, there is no need for the electrical wiring line provided on the front surface side of the heating element **101**. Since the film thickness of the heating element **101** is about 0.01 to 0.05 μm, the step height is significantly smaller than that in the above configuration. Thus, a sufficient coverage property can be secured with the protective film **105** having a film thickness of about 0.15 to 0.3 μm, so that the protective film **105** can be thinned and the efficiency of heat transfer to ink is remarkably improved. This can achieve both reduction in power consumption and high quality by stabilizing foaming. It can also be expected that the patterning accuracy and reliability of the cavitation resistant film **106**, the adhesion of the ejection port forming member **108** to the substrate **114**, and processing accuracy will be improved, and thus, not only high quality but also a manufacturing advantage can be obtained.

In order to obtain a more uniform ejection characteristic, accuracy is necessary for variations in foaming and resistance values, so that a base (lower area) of the heating element **101** is preferably flat. Conventionally, it has been difficult to arrange a wiring pattern or the like immediately under or around a heating element so as not to generate a step height. In the configuration of the present embodiment, the electrical wiring line **103** of each layer and the base portion of the heating element **101** are flattened by processing such as CMP. As a result, as shown in FIG. **2**B, a contact surface of the connecting member **102** which is in contact with the heating element **101** and a contact surface of the insulating film **104** which is in contact with the heating element **101** are provided on the same plane.

As described above, flattening the base (lower area) of a heat generating resistor layer allows the electrical wiring line **103** of a pattern such as a signal wiring line and a power supply wiring line to pass immediately under the heating element **101**, that is, through the insulating film **104** between a central area **122** to be described later and the base material **113** or around the heating element **101**. Further, since a transistor can be arranged in the area, the area of the element substrate **100** can be reduced, the cost of the print head can be reduced, and the density of the ejection port **109** can be increased. In the present embodiment, as shown in FIG. **2**B, the drive circuit **203** and a field oxide film **132** are formed in an interface area between the base material **113** formed of Si and the insulating film **104**.

Such a configuration enables to multi-layer the electrical wiring line **103** while suppressing an influence on the characteristics of the heating element **101**. Further, allocating a plurality of wiring layers to the electrical wiring line **103** enables to significantly reduce power supply wiring resistance.

In the present embodiment, the electrical wiring line **103** has three layers at different distances from the heating element **101** in a direction orthogonal to the plane of the element substrate **100**. The electrical wiring layer includes an electrical wiring layer **103***a* farthest from the heating element **101**, an electrical wiring layer **103***b* second farthest from the heating element **101**, and an electrical wiring layer **103***c* closest to the heating element **101**. The electrical wiring layer **103***a* is allocated to a signal wiring layer or a logic power supply wiring layer for driving the heating element **101**. Further, the electrical wiring layer **103***b* is allocated to the signal wiring layer or the logic power supply wiring layer for driving the heating element **101** and a wiring layer for supplying the heating element **101** with a current. Further, the electrical wiring layer **103***c* is allocated to a wiring layer for supplying the heating element **101** with a current.

Here, in a conventional element substrate, a VH wiring layer provided with a positive side (one side) wiring line for passing a current through a heating element and a GNDH wiring layer provided with a negative side (the other side) wiring line are provided so as to face each other. However, in such a configuration, since the VH wiring line and the GNDH wiring line face each other in a large area, there is a possibility that the frequency of interlayer short circuits caused by foreign matter will increase, and there is concern that yield decreases. Further, each of the VH wiring line and the GNDH wiring line uses one layer, which costs. Thus, in the present embodiment, the VH wiring line and the GNDH wiring line are provided in the same layer. It is only required that at least a pair of the VH wiring line and GNDH wiring line be provided in parallel in the same layer. A detailed description will be given of the electrical wiring layer in the present embodiment.

FIG. **3**A is a plan view showing the element substrate **100** and FIG. **3**B is an enlarged view of the electrical wiring layer **103***b* in a portion IIIB in FIG. **3**A. The electrical wiring layer **103***b* includes a signal wiring line (not shown) for driving the heating element **101**, a logic power supply wiring line (not shown), and a power supply wiring line (electrical wiring group) for supplying the heating element **101** with a current. The power supply wiring line for supplying the heating element **101** with a current includes a VH wiring line **103***b***1**, which is a power supply wiring line connected to the entrance side of the current flowing through the heating element **101**, and a GNDH wiring line **103***b***2**, which is a wiring line connected to the outlet side of the current flowing through the heating element **101**. The VH wiring line **103***b***1** and the GNDH wiring line **103***b***2** are arranged alternately in the X direction as shown in FIG. **3**B. In the electrical wiring layer **103***b*, a plurality of pairs of the VH wiring line **103***b***1** and GNDH wiring line **103***b***2** run across the entire area of the element substrate **100**. In a case where the element substrate **100** has a parallelogram shape as in the present embodiment, the power supply wiring line is connected along the oblique side of the outer shape of the element substrate **100** in a section L in the figure.

FIG. **4**A is a plan view showing the element substrate **100** and FIG. **4**B is an enlarged view of the electrical wiring layer **103***c* in a portion IVB in FIG. **4**A. The electrical wiring layer **103***c* includes a power supply wiring line for supplying the heating element **101** with a current. The power supply wiring line for supplying the heating element **101** with a current includes a VH wiring line **103***c***1**, which is a power supply wiring line connected to the entrance side of the current flowing through the heating element **101**, and a GNDH wiring line **103***c***2**, which is a power supply wiring line connected to the outlet side of the current flowing through the heating element **101**. The VH wiring line **103***c***1** and the GNDH wiring line **103***c***2** are arranged alternately in the Y direction as shown in FIG. **4**B. In the electrical wiring layer **103***c*, a plurality of pairs of the VH wiring line **103***c***1** and GNDH wiring line **103***c***2** run across the entire area of the element substrate **100**.

The VH wiring line **103***c***1** and the GNDH wiring line **103***c***2** are connected to the heating element **101** via the connecting member **102**. The VH wiring line **103***b***1** and the VH wiring line **103***c***1** are connected in different layers via a through-hole wiring line at a location where the wiring lines intersect and overlap each other in a case where the element substrate **100** is viewed from the front (when viewed from a viewpoint on a line perpendicular to the electrical wiring layer). Additionally, the GNDH wiring line **103***b***2** and the GNDH wiring line **103***c***2** are also connected in different layers via a through-hole wiring line at a location where the wiring lines intersect and overlap each other in a case where the element substrate **100** is viewed from the front.

FIG. **5** is a diagram showing a cross section taken along a line V-V in FIG. **4**B. A through hole **50** is formed between the VH wiring line **103***b***1** and the VH wiring line **103***c***1**. The VH wiring line **103***b***1** and the VH wiring line **103***c***1** are connected via the through-hole wiring line formed in the through hole. The connection between the VH wiring line **103***b***1** and the VH wiring line **103***c***1** has been described as an example here, but the same applies to the GNDH wiring line **103***b***2** and the GNDH wiring line **103***c***2**. In the present embodiment, the electrical wiring layer **103***c* is routed in the X direction and the electrical wiring layer **103***b* is routed in the Y direction.

Here, the thickness (wiring thickness) of the electrical wiring layer **103***c* is 0.8 to 1.2 μm and the thickness of the electrical wiring layer **103***b* is 0.3 to 0.6 μm. Thus, the electrical wiring layer **103***c* has a film thickness larger than that of the electrical wiring layer **103***b*. In a substrate longer in the X direction than in the Y direction, such as the element substrate **100**, a voltage drop due to wiring resistance can be reduced by routing a wiring line with a large film thickness and a large cross-sectional area along a longitudinal direction (X direction) than by routing a wiring line with a large film thickness in a lateral direction (Y direction). Accordingly, in the present embodiment, the electrical wiring layer **103***c* routed in the X direction which is the longitudinal direction has a film thickness larger than that of the electrical wiring layer **103***b* routed in the Y direction to reduce the voltage drop.

FIGS. **6**A, **6**B, and **6**C are diagrams illustrating wiring resistance from a heating element driving electrode **600** to the heating element **101** and showing results of simulating a voltage drop caused by the wiring resistance. Here, a voltage drop in the case of driving simultaneously a total of four rows (rows A to D) of 32 heating elements **101** in one row is simulated. FIG. **6**B shows a simulation result of routing the electrical wiring layer **103***c* with a large film thickness in the longitudinal direction (X direction) as in the present embodiment and FIG. **6**C shows a simulation result of routing the electrical wiring layer **103***c* in the lateral direction (Y direction). It can be seen that in the case of the shape of the element substrate **100** and the arrangement of the heating elements **101** in the present embodiment, a voltage drop value is high in a position **601** (data number 0) and a position **604** (data number 32) where the heating element **101** farthest from the heating element driving electrode **600** is located.

Here, a comparison will be made between the simulation result of routing the electrical wiring layer **103***c* with a large film thickness in the longitudinal direction (X direction) shown in FIG. **6**B and the simulation result of routing the electrical wiring layer **103***c* in the lateral direction (Y direction) shown in FIG. **6**C. A comparison between values at the position **601** (data number 0) and the position **604** (data number 32) shows that a voltage drop value is smaller in the case of routing the electrical wiring layer **103***c* in the longitudinal direction (X direction) shown in FIG. **6**B.

As described above, the VH wiring line and the GNDH wiring line are provided in the same layer. As a result, it is possible to reduce an area where the power supply wiring lines different between the layers face each other (only at locations where the power supply wiring lines intersect each other). This makes it possible to suppress the frequency of interlayer leakages caused by foreign matter generated at the time of generating a wiring line or the like and can achieve a reduction in yield in the manufacturing process. Further, since the VH wiring line and the GNDH wiring line are alternately routed in the same layer, wiring layer constituents can be reduced, so that an increase in cost can be suppressed.

Second Embodiment

A description will be given below of a second embodiment to which the present invention can be applied with reference to the drawings. Since the basic configuration of the present embodiment is the same as that of the first embodiment, characteristic configurations will be described below.

FIG. **7**A is a plan view showing the element substrate **100** in the present embodiment and FIG. **7**B is an enlarged view of the electrical wiring layer **103***b* in a portion VIIB in FIG. **7**A. The element substrate **100** in the present embodiment has a rectangular outer shape as shown in FIG. **7**A. That is, since the outer shape of the element substrate **100** is a rectangle extending in the X direction and the Y direction, the power supply wiring line is connected along the Y direction in a section L in the figure, and the VH wiring line **103***b***1** and the GNDH wiring line **103***b***2** are arranged alternately in the X direction.

FIG. **8**A is a plan view showing the element substrate **100** and FIG. **8**B is an enlarged view of the electrical wiring layer **103***c* in a portion VIIIB in FIG. **8**A. The VH wiring line **103***c***1** and the GNDH wiring line **103***c***2** are alternately arranged in the Y direction as shown in FIG. **8**B. The VH wiring line **103***c***1** and the GNDH wiring line **103***c***2** are similarly run across the entire area of the element substrate **100**.

A through hole is provided at a location where the power supply VH wiring line **103***b***1** and the VH wiring line **103***c***1** intersect and overlap each other. The power supply VH wiring line **103***b***1** and the VH wiring line **103***c***1** are connected via a through-hole wiring line. The GNDH wiring line **103***b***2** and the GNDH wiring line **103***c***2** are also provided with a through hole at a location where the GNDH wiring line **103***b***2** and the GNDH wiring line **103***c***2** intersect and overlap each other. The GNDH wiring line **103***b***2** and the GNDH wiring line **103***c***2** are connected via a through-hole wiring line.

Third Embodiment

A description will be given below of a third embodiment to which the present invention can be applied with reference to the drawings. Since the basic configuration of the present embodiment is the same as that of the first embodiment, characteristic configurations will be described below.

FIG. **9** is a diagram showing a power supply wiring layer in the present embodiment. The element substrate **100** of the present embodiment includes the electrical wiring layer **103***a* farthest from the heating element **101**, the electrical wiring layer **103***b* second farthest from the heating element **101**, the electrical wiring layer **103***c* closer to the heating element **101** than the electrical wiring layer **103***b*, and an electrical wiring layer **103***d* closest to the heating element **101**. The electrical wiring layer **103***a*, the electrical wiring layer **103***b*, and the electrical wiring layer **103***c* are the same as those in the first and second embodiments. The electrical wiring layer **103***d* is an electrical wiring line having the same shape and the same arrangement (same configuration) as those of the electrical wiring layer **103***c*. That is, the VH wiring line **103***c***1** of the electrical wiring layer **103***c* and the VH wiring line **103***d***1** of the electrical wiring layer **103***d* overlap each other, and the GNDH wiring line **103***c***2** of the electrical wiring layer **103***c* and the GNDH wiring line **103***d***2** of the electrical wiring layer **103***d* overlap each other. As described above, the VH wiring lines overlap each other and the GNDH wiring lines overlap each other, so that it is possible to reduce an area where the VH wiring lines and the GNDH wiring lines face each other and suppress leakage occurring in a case where foreign matter is mixed between the layers.

A through hole is provided between the VH wiring line **103***c***1** of the electrical wiring layer **103***c* and the VH wiring line **103***d***1** of the electrical wiring layer **103***d*. The VH wiring line **103***c***1** and the VH wiring line **103***d***1** are connected via a through-hole wiring line. A through hole is also provided between the GNDH wiring line **103***c***2** of the electrical wiring layer **103***c* and the GNDH wiring line **103***d***2** of the electrical wiring layer **103***d*. The GNDH wiring line **103***c***2** and the GNDH wiring line **103***d***2** are connected via a through-hole wiring line.

While the present invention has been described with reference to exemplary embodiments, it is to be understood that the invention is not limited to the disclosed exemplary embodiments. The scope of the following claims is to be accorded the broadest interpretation so as to encompass all such modifications and equivalent structures and functions.

This application claims the benefit of Japanese Patent Application No. 2021-143903 filed Sep. 3, 2021, which is hereby incorporated by reference wherein in its entirety.

What is claimed is:

1. An element substrate comprising:

a plurality of arranged heating elements; and

an electrical wiring line configured to supply the heating elements with power,

the electrical wiring line being provided in a first electrical wiring layer and a second electrical wiring layer overlapping the first electrical wiring layer,

wherein the first electrical wiring layer includes a first wiring line connected to one connecting unit of the heating elements and a second wiring line connected to the other connecting unit of the heating elements,

wherein the second electrical wiring layer includes a third wiring line connected to the first wiring line and a fourth wiring line connected to the second wiring line,

the first electrical wiring layer including a first wiring group in which at least one pair of the first wiring line and the second wiring line are provided in parallel,

the second electrical wiring layer including a second wiring group in which at least one pair of the third wiring line and the fourth wiring line are provided in parallel,

wherein a wiring line of the first wiring group and a wiring line of the second wiring group intersect when viewed from a viewpoint of a line orthogonal to the first electrical wiring layer, and

wherein the first wiring group and the second wiring group are different in wiring thickness.

2. The element substrate according to claim **1**, wherein

in the first electrical wiring layer, a plurality of pairs of the first wiring lines and the second wiring lines are provided, the first wiring lines and the second wiring lines being arranged alternately, and

in the second electrical wiring layer, a plurality of pairs of the third wiring lines and the fourth wiring lines are provided, the third wiring lines and the fourth wiring lines being arranged alternately.

3. The element substrate according to claim **1**, wherein

an outer shape is a parallelogram, and

a wiring line of the first wiring group and a wiring line of the second wiring group are provided along respective edges of the outer shape.

4. The element substrate according to claim **1**, wherein

an outer shape is a rectangle, and

a wiring line of the first wiring group and a wiring line of the second wiring group are provided along respective edges of the outer shape.

5. The element substrate according to claim **1**, wherein

a wiring line of the first wiring group and a wiring line of the second wiring group are provided across an entire area of the element substrate, and

one wiring group extending in a longitudinal direction of the element substrate out of the first wiring group and the second wiring group has a wiring thickness larger than a wiring thickness of the other wiring group extending in a lateral direction.

6. The element substrate according to claim **1**, wherein a through hole is provided between the first electrical wiring layer and the second electrical wiring layer, a wiring line of the first wiring group and a wiring line of the second wiring group being connected via a through-hole wiring line passing through the through hole.

7. The element substrate according to claim **1**, wherein the electrical wiring line is a metal and is made of any one of Al, Cu, Ag, Au, Pt, W, Ni, and Co or an alloy including any one of Al, Cu, Ag, Au, Pt, W, Ni, and Co.

8. The element substrate according to claim **1**, further comprising:

a plurality of supply ports capable of supplying the heating elements with a liquid; and

a plurality of collection ports capable of collecting a liquid from the heating elements.

9. The element substrate according to claim **1**, further comprising a plurality of electrodes configured to transfer power from outside to the heating elements.

10. The element substrate according to claim **1**, further comprising:

a third electrical wiring layer including a fifth wiring line connected to the first wiring line and a sixth wiring line connected to the second wiring line,

wherein the third electrical wiring layer includes a third wiring group in which at least one pair of the fifth wiring line and the sixth wiring line are provided in parallel, and

wherein a wiring arrangement in the third wiring group is identical to a wiring arrangement in the first wiring group.

11. A print head comprising the element substrate according to claim **1**.

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